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ASTP VISUAL OBSERVATIONS DEBRIEFING

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ASTP

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This document is the transcription of the postflight experiments debriefing conducted by the ASTP crew at the Lunar Science Institute on August 12, 1975. The companion documents to this transcription is the Experiments Debriefing. Where possible, questioners have been identified by their last names. However, the attendees and questioners are too numerous to identify or list here. The astronaut participants are as follows.

STAFFORD	Thomas P. Stafford	Commander
BRAND	Vance D. Brand	Command Module Pilot
SLAYTON	Donald K. Slayton	Docking Module Pilot

A series of three dots (...) is used to designate those portions of the communications that could not be transcribed because of garbling. One dash (-) is used to indicate a speaker's pause or a self-interruption and subsequent completion of a thought. Two dashes (- -) are used to indicate an interruption by another speaker or a point at which a recording was terminated abruptly. In instances in which the transcription team was unable to verify a word, the phonetic equivalent is provided followed by a bracketed question mark ([?]).

VISUAL OBSERVATIONS DEBRIEFING

HARDEE Gentlemen, first of all, we'd like to welcome the crew back from a very successful mission. And due to the time constraints, let's press on with this. First of all, we have an attendees' list that we'd like everyone to sign their names and organizations so they can get a copy of the debriefing minutes here. And we have a slight change in agenda from that published earlier. We're going to spend a short time, maybe 15 minutes or so, discussing the hardware systems as a result of some of the things that occurred during the mission. And then we will go by discipline. Dr. El-Baz, the PI for the Earth Observation Experiment, will introduce his coinvestigators and will discuss the experiment by discipline at that time.

First of all, I hope that everybody has had an opportunity to read the Technical Crew Debriefing that the crew had prepared in Hawaii. I think Dr. El-Baz and most of his people have had an opportunity to do that, so in discussing the hardware systems we'd like to approach the subject on the basis of the questions that we have as result of understanding a lot of their comments expressed in this particular debriefing. At this point, let me ask Dr. El-Baz to address some of the questions he may have and then I have a couple of prepared questions from the camera people.

EL-BAZ Good morning, everybody. Tom Stafford will be here shortly. We have Deke Slayton and Vance Brand and would like to ask a few questions about both the silver camera and the black camera, following the comments made in the crew debriefing. Vance was of the opinion that the Hasselblad reflex camera does give you something, because you can see through it, provided you use the 50-millimeter lens. With the 250-millimeter lens, they thought there was too much loss of light, because of the transmission characteristics of the lens, and you don't see the target. So, in general, would you still think the reflex camera does something for you, Vance?

BRAND I think it's best with the 50-millimeter lens. When you put on a 250-millimeter lens, you're hamstrung by the light loss and the length of the camera when you're trying to get close to the window. I don't know that we had complete agreement on that, but that's the way I felt. Tom and Deke probably have their own ideas.

SLAYTON I agree with you, generally. I never was able to see anything through that lens; it was just kind of a blur. I didn't feel that I was gaining much by looking through it. What we're saying here is that we probably could have done about as well without the reflex system on it. I understand you did get some good pictures despite what we thought we were seeing.

EL-BAZ That's the point. Yes.

SLAYTON Whether they were good because we were looking through versus alongside, I'd hesitate to say.

EL-BAZ Yes, you couldn't really see very well, but the pictures came out very nicely. So it's a matter of your not seeing the scene as you get the photograph.

SLAYTON I still think it's comforting to be able to see your picture outlined through a reflex if you don't have too many of these accompanying disadvantages.

EL-BAZ That's correct. And you used the 35-millimeter quite a bit and the photographs from the 35-millimeter are excellent, even though we weren't really prepared for either the film or the lenses to be used for exterior photography.

SLAYTON There again, I had the same feeling with the 300-millimeter lens, though, on the 35-millimeter camera. Maybe this again is a function of our particular orbit. We were traveling quite fast and trying to track anything through that lens was almost impossible. I always had the feeling that I was going to get image-motion blur. Whether we did or not, I don't know.

EL-BAZ You had excellent photography and the camera people really said that the 300-millimeter lens is the only one that you can use with the 35-millimeter camera for outside photography.

SLAYTON Well, we took it off because we thought we weren't getting anything, from the way it looked to us. We just couldn't track a thing. We finally went back to the other lens; that's what we shot most of our stuff with.

EL-BAZ A couple questions related to the attitude of the spacecraft. You remember we had worked on this attitude and you told us it wasn't really a very good one. And Tom figured out a new attitude for us. Why was the first one bad really? And how was the second attitude?

STAFFORD Using the first one, we were pointed toward the horizon too much and that doesn't do any good.

EL-BAZ Were you able to see the horizon? You couldn't see the horizon, though, could you?

BRAND Oh, yes. We could.

SLAYTON We could see about that much black sky above it. That was the problem on the first attitude.

STAFFORD When we got right down to the nadir, we couldn't get down there that close.

SLAYTON So we took that first 10-degree increment, thinking that might correct it, and we still were seeing black sky. So we took the next 20 degrees and that put us in real good shape.

EL-BAZ In the new attitude, were you looking straight down or just ahead a little bit?

SLAYTON You could still see way out ahead.

STAFFORD You could still see way out ahead for what you can resolve with the eye as far as your lead-in. But this brings us to another problem on which we got a lot of discussion. When you look at a specific target in a lead-in, upside down, this makes it extremely difficult to think. To lead in, you should be right side up, pitched down.

BRAND Especially for identification. If you're upside down, all these years of training and living down here are certainly thrown out the window. You're saying, well, let's see, is north to the left or right? Let's see, I followed that little river and if I go north is it left or right or back this way? You have to think everything out.

SLAYTON You've got a 50-50 chance of being right, but you're usually wrong.

BRAND And you have 15 seconds or 20 seconds to do everything.

EL-BAZ Okay. And was this problem of not being able to see from the window very well something new because of something in the couches or the fact that you were too far down from the windows in the old attitude, or is it because you had to get up too far to look at it?

STAFFORD You couldn't get the nadir.

EL-BAZ Oh, I see. Okay.

STAFFORD First, we were pitched up like that, we had a view out here, but what you're really interested in is shooting closest down here. And it was hard to get to.

SLAYTON By the time you got in where you could kind of shoot to the nadir, the target was almost gone. And we were effectively losing 30 degrees of sweep underneath us, which would have been the optimum angle for shooting pictures.

EL-BAZ That's correct.

EL-BAZ How about the mapping-camera attitude? Was this also bothersome?

STAFFORD It wasn't the best.

BRAND It wasn't optimized at all for visual observations.

EL-BAZ Okay. Very good. We have your comments on the color wheel and we think we agree with you on this business of the lighting inside spacecraft, the comments on the Visual Observations Book in the Technical Crew Debriefing, so we'll not go over this.

There are problems with some of the focus on the film magazines and we think that some of this is due to leaving the extension ring that we used for electrophoresis on the camera. Could this be the case? Because everytime we used the electrophoresis and then shot out the window, this happened. Every single time.

SLAYTON You mentioned that yesterday and I haven't had a chance to track back through the Flight Plan and find out. It's embarrassing if that happened. I guess it could have.

EL-BAZ It could happen, especially since we had nothing in the procedures to tell you to remove that ring after the electrophoresis run.

BRAND Did somebody check the camera when it came home?

EL-BAZ No, I don't think we did. The camera people are not here yet.

SPEAKER It wasn't all the way through, Vance. We noticed that at the end of the electrophoresis roll, for example. The few

frames there looked like they were out of focus like it was probably left on, but it wasn't all of them.

SLAYTON The only reason I hesitate to think that happened is because, if we had done that, we really wouldn't have had any reason to take that thing off later, either. And it seems to me like everything we shot from then on would have been poorly resolved.

SPEAKER Each time at the end of electrophoresis, the dark slide went in and there was a blank at that point, so you had reconfigured the camera some way probably.

SLAYTON My only point is, if we'd made the mistake that Farouk is anticipating here, it seems to me we never would have corrected it through the whole flight because we never had any reason to correct it. We'd have been exchanging lenses and left that spacer in there forever.

EL-BAZ That's correct; we used the photography of electrophoresis several times during the mission and this happened with the film also, several times.

SLAYTON But there was only one split in there, where we switched that camera out and did mapping and back in for electrophoresis. We did all the electrophoresis in 2 days.

EL-BAZ Right. There are several handheld shots also with the black camera that were taken right after the electrophoresis experiment and these are out of focus. And the only other one that is out of focus is F39 that you said something about, Deke. You said that you thought that this was orange filter. So we had no out-of-focus photography with the silver camera. So the reflex can help in that you can see that something is wrong. And you mentioned that on the tapes also that there was something wrong with the focus and you looked at it and it wasn't the orange filter but the focus.

SLAYTON That's right.

EL-BAZ Yeah. Very good. Do we have any more hardware or camera questions?

SPEAKER Let me ask one. You had some comments in the Technical Crew Debriefing concerning the binoculars versus the spotting scope. We'd had a couple of questions like that. Would you elaborate on your comments there in terms of what your preferences were?

SLAYTON It's my opinion that we should have left everything alone and stayed with our good old 10-power glasses, probably. That was more than adequate. On the other hand, I can completely understand the Skylab guys in the orbit that they were in arriving at the conclusions they did. But I think that the

altitude we were in and as fast as we were traveling, I had zero success tracking anything with the spotting scope and never could have seen anything through it at any power.

STAFFORD I could track, but it's really meaningless unless you had a specific target that you wanted to see and lead into; then it's going to be very difficult to find it because the field of view is so narrow.

SLAYTON Things are just going so fast.

STAFFORD Let me tell you something that was noticeably different. Did you hear my air-to-ground comments on the difference between the Gemini altitudes and this? These thunderbumpers look like they're coming about a quarter of a way up versus being about that big from the Gemini altitude. And the lead-ins and the angular bearing rates are fantastic compared to Gemini.

BRAND I'd go a little further than that. If I had the most optimized perfect pair of binoculars or spotting scope available, I never would have used it, because I never had time to search around and get it on. Even assuming the focus was okay and everything was perfectly run by a computer in the spotting scope, I never would have used it, not once. We could see pretty well with the eyeball, first of all.

SLAYTON That's right. We had a real good definition with the bare eye.

BRAND And it was just too hard, too little time.

HARDEE Okay. Thank you. Let's press on then with the discussions in the various disciplines and, Farouk, will you introduce your coinvestigators there?

EL-BAZ Yeah. I want to get on with this resolution of the eye and we'll get all the things that we had there for eye resolution out of the way first. We'll do this with slides and then we'll have each of the coinvestigators run through through some of the slides and ask questions about the visual observation sites. May we have the first slide, please?

For everyone's benefit, we had a few targets that were scheduled in the Flight Plan just to set the limits of eye resolution on the mission. Vance, you had the chance to look at the Bonneville area. Were you able to see the race track?

BRAND Yes.

EL-BAZ And is it the one that we thought it was? The Wahsahchasses[?] are on the right side there and the Great Salt Lake with the two halves and the Bonneville Lake is the white patch. Did you mark it on the book or something?

BRAND First of all, the picture I had, pointed out the area and I compared that picture to the ground and I saw what looked

like a fairly wide linear scratch or stripe on the ground. Right at this point, after all this time and without the benefit of that same picture, I can't tell you where it is on that slide. At the time, I did see it.

EL-BAZ Was it darker in color? Do you think you saw it because it was a different color?

BRAND Well, I would say it was more of a textural difference.

EL-BAZ Okay. Very good. Next slide please. We had the pyramids of Egypt as one of the targets of resolution because they are built from material the same color as the surrounding area, but there will be a textural difference because the pyramids are built with large stones.

BRAND I don't believe now that I saw them. I had the benefit of two passes. The first pass, I saw two little dots that I thought possibly were pyramids. At that point, I wished I had a map of the pyramids on the ground so I could see what they're supposed to look like. I think probably what I saw were fields or something like that. So, I would say, no, I didn't see them.

EL-BAZ Okay. In one group of photographs, we can identify the pyramids and there is another batch that we cannot. So the Sun angle may have a great deal to do with it. And this is the

picture that you can see them on if you enlarge it very much. You can only see two big ones and a third tiny one.

SLAYTON With a low Sun angle, you might have a reasonable chance of seeing them.

BRAND I think you should be able to see them, because we saw things in that size range. Tom very easily saw the taxiway at El Paso Airport and a hangar, I believe.

STAFFORD A hangar. There was a couple of buildings.

BRAND The whole question for the pyramids is how good is the contrast.

EL-BAZ Yes. Also, whether you know what you are looking at; for instance, Tom knew that airport and knew where the hangars were on the runway and such.

STAFFORD I looked down and there was kind of a desert area with a green river running through it that I thought looked like the Rio Grande. I looked down and there was White Sands over there, Biggs Air Force Base with its runway, and the two runways at El Paso, the taxiway, and these two buildings over here.

EL-BAZ Very good. Next slide please. All right, we had also something over the intricate patterns of the Nazca Plains. Tom, you got pictures and I don't whether you saw anything or not.

STAFFORD The first time the clouds went all the way to the mountains and we got nothing. This slide was taken on the second pass. I can't say that I saw them. I remember this little bay in here and Vance was helping me lead in. I saw this little bay up here and I thought I saw a white streak in here, but I snapped the picture and I couldn't really say that that was it. I thought I saw something but I sure wouldn't say that was positive.

BRAND I didn't see anything.

STAFFORD And so, I couldn't say that I saw them. No. Now whether it was a white field or something in that area, I just don't know.

BRAND This is one case where being upside down hurt us. The identification problem was very hard here.

STAFFORD Can you see them on that photograph?

EL-BAZ I couldn't, really. I know where they are, but I have not enlarged this or looked at it in detail. But this is exactly where you would expect them. This is that region.

Next slide please. Okay. And you did say something about being able to see first of all glaciers and then fern lines

on glaciers. Did you see that over the northwest as well as over the Alps?

STAFFORD I had the Alps and it was cloud cover; we got nothing on it. It was hazy. I couldn't see anything but Vance saw something.

BRAND The best case, I believe, was in the Alberta, British Columbia, area. I very easily saw a fern line on one big glacier up there.

SLAYTON So did I.

EL-BAZ How did you make that distinction? Why do you think you were able to see that? Because of a color or texture?

BRAND Textural and - -

SLAYTON Color gradation - -

BRAND - - color and even shinyness, you might say. Surface texture, I guess.

EL-BAZ The ice being more - -

SLAYTON Kind of a gray compared to pure white.

STAFFORD Yes, it goes from white to gray. And the fern line wasn't just a straight line; it was kind of jagged. It wasn't a clear line.

BRAND It was fairly clear. Crescent.

STAFFORD Well, it had kind of a little curve in it.

EL-BAZ Okay. Thank you.

SLAYTON But I thought I could see texture down below it also, that sort of looked like flow patterns going parallel with the glaciers.

BRAND You could very definitely. It looked like old ice down below.

EL-BAZ Okay. Very good. Now before we start talking about the disciplines, we want to summarize some of the results of the ocean ground truth collection. Dr. Robert Stevenson will start this by talking about the ground-truth collection in the Mediterranean and Tasman Sea and so on.

STEVENSON Too bad we didn't have other chances to look at that. That's what we thought about everything. It really helps to have repeat assurances.

BRAND The day before, it was bright and clear.

STEVENSON Well, I think before you took off you had some indication of the kind of ground truth backup that was going to take place. I made a list of those that have come in to date and I keep finding everyday that some other ship was involved that had

received the message before the flight and had not indicated that he was going to do anything until after the flight was over. So the data are piling up in my office about 3 feet high. But I think you can see from that list that certainly the U.S. Navy and the fleets and air forces of New Zealand, Australia, and Great Britain were interested enough to become involved. To refresh your mind as to where they are located and where they are planned, I'll go over them.

The first one was on revolution 17 and we sure appreciated that fact that you left that in the Flight Plan, running north from East Cape in New Zealand. In that area, the Royal New Zealand Air Force had a P3 they flew the day before. They flew the day launched and then the day after you launched, which was your visual observation and photographic day. Then they flew the third day, and the day after that. During the same time, the New Zealand Navy also had a research vessel along that line and I'll show you some of those data. They're rather interesting, because not only did they run water temperatures, but they also did some sound-velocity measurements and they caught an eddy and you can see the change in sound velocities in that eddy as we talked about before you went up. Vance, that was one area where you said you thought you saw a scum line, but it went by so fast. We'll look later and chat about that later, maybe.

The second area was along the east coast of the United States, along several of these revolutions that you eventually made. In that case, Preserver (one of the ships standing by in an event of an immediate abort after launch) went farther north and released four drifting buoys with transmitters that transmitted to Nimbus-F. The Nimbus-F was positioning the buoys about once a day with the precision of a kilometer. And those buoys drifted throughout your entire mission. They worked beautifully, by the way. Hopefully we can tie some of the photography in with that area. I don't know what they got of that area, but I think they did get some. In coming around the world, the next line was running southwest from the bight of Spain[?] and in that line we had the U.S. Navy research vessel Caine and they ran that line from July 15 through July 22, so they started the day of the launch and they continued to run back and forth along that line for 6 days getting some detailed temperatures and other data. Then again, the day before, the day of, and the day after, your revolution 73, the Navy flew a P3 along that line dropping expendable bathythermographs (XBTs). That was the greatest success from my point of view because that's when Tom suddenly began to see the internal waves and the boundary; and the photographs are beautiful. They're really spectacular and that boundary was precisely where we had hoped it was. It's

right across the flight line and the data looked great. I've seen some of the data and they really look good, so that was a spectacular sucess.

The next planned line was the Royal Air Force line that ran more or less east and west from southwestern England, although they didn't start dropping XBTs until they got just off the tip of Ireland and that was revolution 160. They again flew a 3-day sequence. On the day before the revolution, they had really fine weather, they got good observations, and the data looked pretty good. The day of your pass, it was pretty cloud covered. They noticed 10 tenths for two-thirds of the line and 25 percent and 75 percent for the rest. Again, it was the type of situation where operations in one shot over the area is going to hurt if the weather's going to move in. Then we had two groups come into the picture that came in on their own more or less, but we certainly welcomed the data. The carrier Roosevelt was on the return from their final deployment — (Roosevelt henceforth will be used for a training carrier along the East Coast) — from the Mediterranean to the U.S., so they made a complete transect of the Atlantic Ocean dropping XBT's all the way and making weather observations right across.

SPEAKER What's an XBT?

STEVENSON Expendable bathythermograph. It's a probe which is dropped into the water and it makes a record of the temperature of the water versus depth to a depth of 1500 feet. They're expendable because, when the probe comes to the end of the very fine copper line that attaches it to the recorder on deck, then the probe breaks the line. They're fairly cheap devices, so you don't worry about throwing them over. In that way, you can throw them from an aircraft too. You don't have to lower something and pull it back up.

Anyway in two cases, Roosevelt happened to cross at times when there were visual observations. And I haven't seen the Roosevelt data yet, but I'm sure they will be useful. Also the carrier Kennedy, which is now on deployment in the Mediterranean, is sending a mass of data that they took during the redocking. I don't know whether you were looking at Soyuz or at the Mediterranean when you were redocking but there was a beautiful shot of the Mediterranean behind Soyuz and there were two good fronts that showed up well in the videotape. Now I don't know what the photography looks like. I haven't seen it, but in the video there were two good fronts that showed up very beautifully. Did you have a movie camera going at that time here?

STAFFORD I had the DAC going at the right window for the redocking.

STEVENSON That's what we saw yesterday, I guess. Kennedy is our most sophisticated weather ship, oddly enough, even though it's an attack carrier. So, we have some good data coming from that. We also have data from three of our defense meteorological satellites, both visual and IR. The point of that is to try to relate the photography and your observations to the kind of degraded information we were getting from those meteorological satellites. As I mentioned, New Zealand had P3's out 3 days and they had a ship out. The Australians had Her Majesty's Australian Ship Bombard sitting right in the middle of an eddy for 4 days. You remember we did give you information of the approximate location of the eddy. We got good solid data. The report was that it was the most intense warm-water eddy they had yet surveyed. It's 80 miles in diameter, nearly circular, and the first 2 days the ship was there, it was clear sky with a beautiful formation of cumulus over the eddy and sitting right in the center were about a dozen Japanese long-line tuna vessels, which created a navigation hazard for the guys trying to get across and make some temperature transects. It was a very good exercise even though the front moved by and you couldn't see through those clouds. And then, of course, the Royal Air Force were flying Nimrods, which are converted Comets. At cruising speed with all four engines going, they can attain 400 knots. And

you can't drop an XBT at 400 knots, so they shut down two engines and put down third flaps and they flew the whole line, 600 miles, at 240 knots and got some very fine data. Unfortunately again, as I say, the day was cloud covered. Well, as you can imagine from that, much of what you reported is of real value. Not having been able to go through the data yet, I can't comment on all of it. But the spectacular one was the Spanish Coast.

STAFFORD That's the value of these flyovers. When you fly up and down the channel between Los Angeles and San Clemente, you'd go one way and you could see some of the waves and some gyres. If you turn around and fly down the other way with a different Sun angle, there would be nothing but blue. I was looking for all these things and suddenly they popped out within a second right there. Just suddenly when the Sun angle changed, everything was there, the waves and the boundary were all there and we just snapped a series on them. But before that, there was nothing but just solid blue water and then they just suddenly popped.

SLAYTON They don't last long either.

STAFFORD No, they don't last long.

SLAYTON You told me to look about 10 seconds later and they were gone.

STEVENSON So you have to be ready.

STAFFORD You have to be ready and the Sun angle has to be just right. And it's there for just a short period of time and then it's gone.

STEVENSON I suppose if you're in the right attitude and you can look at the glitter as you're moving along, as long as it maintains itself in your field of view, then you can probably pick up features a little better. In this particular case, the glitter came upon you all of a sudden?

STAFFORD Yes. It was just instantaneous.

SLAYTON But you lose it the same way, as soon as the Sun angle changes.

STAFFORD The Sun angle gets lower and lower and then it's gone.

STEVENSON We never got around to computing Sun angle.

BRAND We might add that, because of this fast change that we come across so often, that was one reason why we finally shifted to trying to get three crewmen looking at once. When I went over Seattle once, I had a sunglitter great on Puget Sound. I could see it all with my eyes. After it was all over, there was little time to debrief and I felt like I wanted to paint a picture. I thought, why didn't I use the camera instead of my eyes. You always had to make a choice ahead of time.

So we finally got in the mode where we tried to keep both going at once. Somebody using his eyes and somebody shooting the camera.

EL-BAZ Very good. Now we have Dr. Charlie Yentz[?] from Bigelow[?] Laboratory to summarize the studies of the New England Coast.

YENTZ We can summarize by saying there was a lot of fog. Bob sounds like he mobilized all the navys of the world to help you fellows out. The best I could do was to get two of our research vessels out and we roamed the ocean essentially from Cape Cod to Grand Manan Island at the entrance to the Bay of Fundy. Most of the time we found ourselves in a considerable amount of fog and overcast. However, about halfway through the mission, we did come on a band of discolored water and our mission was essentially to try to find where large accumulations of discolored water were occurring in this area, partially with reference to Red Tide, partially with reference to the general problem of water discoloration in the oceans. I phoned Farouk who got in touch with you. Later I heard that this sighting was confirmed. Is that true? We have no photography of it.

SLAYTON I guess I got mixed emotions about how we confirmed it, because what I saw was obviously discolored water, but it was fairly close in to the coast; what I would be positive of is

that there were sedimentary patterns coming out of some of those rivers onto the oceans. So as far as trying to make a flat statement that that was the sedimentary boundary versus something else, I wouldn't do it. There was obviously a discoloration difference there and I hope we got a few pictures of it, I don't know whether we did or not.

STAFFORD We shot a lot of pictures of that area.

YENTZ As you pointed out, the whole problem with water color is complicated by the fact that sediments, biology, and actually a group of organic compounds that flow into the ocean also discolor the water. If we did get some record of what we call wall-to-wall dinaflagellates, red tide, then I think in your mission, you'll have examples of all three phenomena of color, which is quite nice. I'll just sum up by saying that I think that, if we do have all three of these examples from high altitude, this will be a contribution to oceanography.

EL-BAZ We have also a note from George Small. He's not here today yet, but he had NOAA ship one photograph of the Virginia Key from Miami going all the way to the Yucatan. They did find that all the Gulf Stream was squeezed between the Yucatan Peninsula and Cozumel. They did scan the waters of the Gulf from this area all the way to the Gulf and they also had

some twenty NOAA ships working around the Mississippi River Delta and the coastal waters. So whatever information you had plus the pictures in the gulf waters will be also helpful; the moral of all that is that, from the oceanographic point of view, there was really a lot of good ground support and people who are very enthusiastic about what you were doing and I'm sure the photography will be very helpful to all these parties later.

I want to go through some of the disciplines, discuss some of the photographs, and show you some material you may have not seen and would like to ask you for more additional comments on what you actually saw in flight. We'll start with Bill Muehlberger, who will treat structural geology in a couple of areas.

MUEHLBERGER One thing I would be interested in has nothing to do with structure, but that is the glitter. As you came across the ocean onto land, did your eye have to readjust to be able to discern textural features on land from the glitter all the time?

BRAND No.

MUEHLBERGER You do it all right. Good. I didn't want those oceanographers to beat us out of our land targets. What I'd like to do is work through the Dead Sea/Red Sea strip first and

then move into the southwestern U.S. Lee Silver couldn't be here, so I have to play him for a minute. Those I thought were some of the really spectacular pictures that you picked up through this mission. Some of the other targets that we had taught for you were clouded over too much to show a lot of neat features. But if we are smart enough, we could ask you questions that might increase our knowledge.

Let me start down in the Afar Triangle which is the southern point, but I think it was mainly cloud covered for you. What could you discern there in terms of the big fault scarps? They are the ones that are of particular interest, their linearities or bends. Are there any features beyond what we tried to show you before the mission that come to mind? It was a bad day. The only cloud in all of central Africa went over the area at that moment and it was very solid.

SLAYTON I don't remember seeing anything in there.

MUEHLBERGER The Skylab crew had filled in much of the Sinai Peninsula and on up into the Dead Sea; the part of particular interest is farther north. You took a suite of pictures there that is just gorgeous, makes a perfect fill-in. When someone

wants to give a lecture on the whole region, he can just run long here and look at these pictures and illustrate all these.

That's the Levantine Rift and I have two slides that I'd like to show you and I'd like to ask Vance about his three faults. This is one of the suite that doesn't show all the northern end, but it does illustrate the three major faults that were illustrated in the Visual Observations Book. Then in the debriefing Vance mentioned one going almost due east that worries me a little bit and maybe that's that upside-down position that gives you a little problem with compass direction.

BRAND Because it's been about 3 weeks, I'd like to review my comments and then try to reconstruct it.

MUEHLBERGER You said 1 and 2 were very prominent. One stayed parallel to the coast as I remember. I concluded you were talking about that one.

BRAND That one stood out very clearly; one that I'd never heard mentioned before, that headed up the Turkish coast.

MUEHLBERGER At right angles to the direction that we're looking now? East? West?

EL-BAZ Do you really mean the Turkish coastlines or is it Syria? Do you mean the Turkish coast or the northern end of the Mediterranean?

MUEHLBERGER Let me sketch it for you. Turkey comes around like that and then the eastern Mediterranean coast goes down here; Cyprus would be in here. Is it part of the north-south ... - -

BRAND I guess I didn't know how far south the boundary of Turkey extended. Continue up the Mediterranean coast toward Turkey.

MUEHLBERGER Presumably that would be the continuation this way; it's trying to make another left kink way up there.

BRAND That was very prominent.

EL-BAZ The way you described this is that you had a fan-shaped - number 1 went all along the coast, number 2 got lost in the middle of somewhere, and number 3 headed east-northeast until it joined a river.

BRAND Let me talk about number 3 first. It looked like a sort of a sedimentary plain down there and it sort of got lost in that plain. I couldn't really see where it ended. The river cut it off completely as I recall, but it kind of disappeared before it got to that river.

MUEHLBERGER Was that the Euphrates, the main river with all of its vegetables down the middle of the floodplain that would make it dark and green?

BRAND As to which river, it was off this picture. What I should do is refer to a larger map to reconstruct.

MUEHLBERGER Unfortunately, I don't have any picture that looks the other way to show you that sort of thing.

BRAND But I did not see a sharp end to this and it sort of went into a sedimentary area. I could not determine a precise ending for it.

MUEHLBERGER The other one we have mounted is the closer view of this one. Here's a small lake; the Dead Sea; the Sea of Gallilee; and this one's name I can't remember; but you took a beauty of this area which I'd like to have you look at.

BRAND My overall impression, remembering now, is that, in general, you could not see the ends of these things.

MUEHLBERGER You also talked about the twists and turns. One of these other frames shows it very prominently, and, because of the look angle you had, accentuates the bends a little bit. This one, that one, and that one make the bends look very angular. I'm wondering whether they're really angular or

whether they're long arcing things within the bend. Do you have any remembrances along those lines?

BRAND I'd have to say no, that my overall impression of the first bend was that it was a very jumbled, beat-up area.

MUEHLBERGER A mass of arcs trying to be but they were - -

BRAND They were having a hard time making the corner sort of.

MUEHLBERGER That's a reasonable answer. If your strike slip falls, you have trouble going around corners.

BRAND I can't answer the question the way it was framed in the beginning.

MUEHLBERGER Well, here's a high oblique looking southward into the southwestern U.S. One of the questions that was asked was, where is the southwest end of the metamorphic belts in the Sierra Nevada? Which means looking down along this strip of country and all this picture is supposed to do is jog your memory.

BRAND We had a good pass over that. I had a good chance to look at it and I must say it's like from an airplane. The vegetation overrides so you do not see the gray except in areas there are roads, perhaps quarries, where something has disturbed the vegetation.

MUEHLBERGER Vegetation overrides the color differences of the ground underneath it?

BRAND Yes. Where the vegetation was cut away, in the northern area of where this was supposed to be, I could see some gray. At the northern end of the San Joaquin Valley is where I could see this gray cut away. But as you looked south to what we're really trying to see, the vegetation isn't cut away anyplace and you just can't tell, because the area was covered by golden grass and purplish trees. I will say, though, that as soon as we crossed the Sierras and got into the desert where there wasn't very much vegetation, I wished to myself that the Sierras on the western side had been like this, because I could see all kinds of colors.

EL-BAZ Before we leave this slide, there are two things that will interest many people here. First of all, were you able to see these sets of fractures west of the San Andreas from the estuary? Were they clear? Did you see the San Andreas escarpment itself?

BRAND Yes, very definitely. It was very easy to see. I forget just how I reported it, but I did see other fractures. Basically I think you can see that from an airplane as well.

MUEHLBERGER There's an alinement in this picture that really intrigues my eye and I suspect that's the one that Lee has been working on for quite a while. It cuts across the east part of the world in there. The San Andreas is over here. And I think that's his old fault zone because all the mountain ranges just completely change their orientation and shapes in there. I remember he's been worrying about where it is some of these bands of rocks go. The gray polonna[?] schists and things that were supposed to be down in that area are completely missing.

EL-BAZ It's the one that's supposed to lead into the desert-varnished hills also. Vance, were you able to do anything about these desert-varnished hills? Were you able to see any more in the Mojave or the desert in general?

BRAND I saw some more hills that looked just like varnished hills.

EL-BAZ In addition to the four you already knew about?

BRAND Yes. And I think I called out their locations.

EL-BAZ Fine, because we did not hear this on any of the tapes.

MUEHLBERGER Lee was also interested in the Bahia Concepcion Fault which is on Baja Peninsula. Next slide, please. Here we are looking north up through the gulf and here's where the fault

zone exists. Naturally, we have a cloud on it. Any thoughts concerning this fault zone? It may be one of those old dead spreading centers that presumably is out in the bottom of the ocean now.

BRAND I tried to get the pictures. It was one of those cases where I think pictures overrode viewing. And the cloud cover was a little bit bad and I was - -

MUEHLBERGER Another good example of two people really being needed to do the job.

STAFFORD I think that's generally true all the way through. If you're going to try to get a stereo set of anything, you can forget looking at it. There's absolutely no way to do both.

MUEHLBERGER Well, I had that feeling before we went and you guys have really clearly demonstrated it. One of the recommendations had better be a two-man team then.

BRAND And this was early in the mission, before we got into that two- or three-man mode.

MUEHLBERGER We should have thought of that beforehand. The strip you took across Los Angeles is gorgeous, incidentally. It's probably the best set of photographs that we've had and I don't remember that we mounted one of those. I think those were the main points I wanted to cover.

EL-BAZ Now Carol Breed will talk to us a little bit about some of of the deserts, both in North Africa and Australia.

BREED First, I want to thank you for always being willing to look out the window one more time to try to get one more picture. I know that time was of the essence and yet you always seemed very willing to go on with the earth observations. I'm also very happy that you made as many observations over the deserts as you did. I was really surprised, considering the brevity of your mission, that you could make as many as you did. I have some slides showing the variety of features which you saw and then there are some pictures which I believe are on the rolls here that I'd like to, if I could later, spend a little time going over with you, because pictures that I don't have are very small features that are particular interest to our project but may not be of general interest to the whole audience.

First slide, please. We'll start with something to take you back to where you were and get you thinking about what you

could see in terms of resolution. This is the southern part of the Simpson Desert. This is where you remarked that the dunes looked like straight lines drawn across the landscape. Actually you can only see parts of the dunes here and the ones that are really quite straight occur farther to the north. Can you tell me anything more about the dunes in this area other than what you said at the time?

STAFFORD We all looked at it. You can see the long lines. I couldn't remember anything like the crescents such as we saw on the east side of the Andes or over in China Mongolia.

SLAYTON They tended to be linear.

STAFFORD These were all linears.

BRAND The overall structure was linear and, when you looked at the detailed structure, it was linear too.

BREED I'm glad that that's the case because that's what we know about so far and if you had found something different, I would have been a little concerned. That confirms the classification of that area. Now there is a picture on one of these rolls of some dunes that look very much like this in South Africa and Angola. This would be north of the Namid Desert. There were some very narrow linear features there that appeared to be taking off from some dry river beds.

To me, looking at the pictures, it looked very similar to the ones in the Simpson Desert. So far as I know, these dunes have not been described and I'd like to know if you remember seeing them and, if you do remember seeing them, do you remember noticing any similarity between those dunes and the ones in the Simpson Desert?

EL-BAZ We can look at this later. The strip of photographs was taken with the mapping camera, so nobody was really looking at this terrain at the time unless Deke was. On revolution 40, when you turned the camera on, it was good weather in southwest Africa all through. I don't know if he was looking in that direction or not, but we can look at these pictures later.

BREED Well, the reason that this is of interest is because the more southerly parts of the African continent are well known. But this particular place is not and I didn't know that these dunes were there, I didn't expect anybody to see, report, or map them.

EL-BAZ How about a comment on the Simpson Desert? Do you think any of this color is real?

BRAND It is red!

EL-BAZ Is this the way it looks? Is it dark red, this red? Dark-brownish-red?

BRAND We might have done fairly well with the color wheel on that. The usefulness of the color wheel was a function of how much light we could get on it from outside. I know that I tried once or twice and might have come up with a fairly good representation of the color.

SLAYTON I think the fidelity of the color in those photographs is pretty good. I wouldn't be uncomfortable about taking a color wheel and matching it against the photograph and saying that's pretty good.

EL-BAZ Was there any other desert that looked as red as this one?

BRAND Not as red; they were other red deserts but not as red.

BREED I feel a little bit handicapped in this regard, because we don't have all the transcripts and nine of the deserts you observed were later on in the mission and we don't have transcripts of the recordings yet.

BRAND I must say that I expected the African deserts to be redder than they were, just from hearing people talk. They struck me as being more yellow than I expected.

BREED Okay, the next slide is the African deserts, and I wanted to use it as a contrast.

SLAYTON That's fossil dunes there?

BREED Yes, these are fixed dunes, stabilized by vegetation, all but their crests which are still active. That's quite far south in the Simpson Desert.

SLAYTON Yes, that's down in the south; it's the first thing we'd run into actually crossing the coastline. I remember we ran into this kind of structure, then you get into the red material.

BREED And the material in the center part of the desert and towards the north is considerably redder than all of this, is it not?

SLAYTON Oh yes.

BREED Now this slide is what I think Farouk is talking about. Notice the color difference here in the Egyption Desert. Here you can see some linear dunes. I am not sure that you can see it, but there is a different dunes pattern up there. It doesn't show up to well in projection. It's an entirely different pattern than these large seep[?] dunes right down here. The seep dunes themselves are rather atypical linear dunes because they are a branching, sort of bifurcated features. I noticed right away looking at this that there

is a very distinct color difference between these big dunes and the background. I wanted to ask you if that's real, do you remember?

BRAND This is once again a case where I was concentrating on photography or looking for pyramids. I don't recall that the dunes over in that area stood out all that much. That photograph was a view taken by the mapping camera out window 5.

BREED This is an area in which you were making visual observation, but you did not notice that the dunes stood out in any way?

BRAND I wasn't really looking for them over in that area. But it's not something that attracted my attention.

BREED You can see this area in the center of the desert is considerably redder than the area up here. As you know, within a desert where the dunes are all derived more or less from the same source of sand and presumably by the same processes, we think relative color differences like that can be used to determine a sequence of events; because the longer the dunes sit in a subareal environment, the redder they get. So this kind of color difference is interesting, and I just wanted to know if you had actually observed this kind of thing in the African deserts as a general rule. Are they redder in the southern part and lighter as you get closer to the Mediterranean?

SLAYTON I think there is little doubt that close to the Mediterranean they seem to be fairly light. But some of the material we saw down there in the central part was like this, some if it was more reddish. Of course, around the dark hills down here, you see some little darker material.

BRAND I couldn't draw that conclusion that there is more red in the southern part at all. In the area of the Oweinat Mountains down to Lake Chad, it's rather yellowish as I recall.

EL-BAZ Actually, Carol, these dunes are a lot more weird than you would expect. I flew over these and there are star dunes on top of the seep dunes.

STAFFORD On top of the big long linear ones?

EL-BAZ Yes. The ones that go north-south.

BREED These are much bigger than the ones in the Simpson Desert.

EL-BAZ While we're talking about the linear dunes with star dunes on top, Tom, didn't you say something about this in real time? You said you were looking at dunes, long linear dunes with star dunes on top, maybe over the Gobi?

STAFFORD Yes, there was one you could see. There were huge long dunes with something superimposed on the linear dunes, but I don't remember exactly where.

BREED You were somewhere in China; you were right over this area west of the Hwang Ho River, the Yellow River, right in the Chinese part of the Gobi Desert. Did you take any photographs of the area?

BRAND We sure took a multitude of that area, probably on the 35-millimeter film.

STAFFORD I think this was late in the afternoon. Due to the Sun angles, I could probably see it well. That was why. With a high sun angle, I couldn't have seen anything. The Sun angle means everything in certain features.

BREED Next slide, please. This is the Lake Chad area; I wanted you to look at this because here we have the other major classification of dunes, the crescentic features, which you did observe. Here they are stabilized, they are fixed, and the curvature is not particularly pronounced, but it's pronounced enough that you recognized them as being crescentic dunes. If we could go to the next slide, you could see this one in a little more detail. These are the crescentic dune regions here. Next slide.

STAFFORD Yes, I remember that.

BREED That's just super. This is a dune field in Argentina. What can you tell me about it?

STAFFORD Okay, it's right over the edge of the Andes Mountains. Where the mountains end, there is a little area in between and those start. And you could really see how they were crescents; it looked like occasionally maybe the head of the crescent would wash out, and it would tend to be a linear one with lineations on the side. There are all those other little crescents up on the left. That was the area that you wanted me to look at?

EL-BAZ Yes, that's the only one that we thought existed. We didn't know that there were two dune fields.

STAFFORD We were really taking photographs of that.

EL-BAZ Tom, to remind you, this is the shot with the 250-millimeter lens and it's beautifully centered.

BREED This is really a super picture for many reasons. This dune field is not well known at all.

STAFFORD I'd remembered that there was some type of linear feature. There were two rays. One was on this edge down here, which is nearly a linear. But the big thing was those huge crescents; then something else linear caught my eye. I see what it is now, those very minor ones in the center left part of the picture.

BREED This is a particular variety that I haven't seen anywhere else I have seen a lot of varieties of this generally crescentic dune pattern, but nothing where you have these linear dunes superimposed right on the crescent and they're oriented in this way. That's totally unlike anything I have ever seen anywhere else, so this really is the prize picture as far as desert dune observations went.

STAFFORD On that little field up there, it's just the way the boundary was very well defined, as opposed to the other where this kind of fades out into like a dry lake bed.

BREED One of the things that is very obvious is the relationship between the edge of the alluvial fan and the beginning of the dune fields; it's very, very sharp. That's not a very red dune field, is it?

STAFFORD No, it's not.

BREED Does it look about like the ones you see in the southwestern United States in terms of color?

SLAYTON I would say so. We had a fairly early morning light.

STAFFORD I think it's close. We had early morning light there and low Sun angles. It didn't have the redness like the Simpson does or anything like that.

BREED Well, that was what I was getting at. The reason I asked that is that this is in a latitude where you might expect redder dunes. We don't have any pictures or any record yet in the transcript of any area with any star dunes, but you did mention the ones that you saw in the Chinese Region. Did you see any other star dunes anywhere?

STAFFORD I didn't. Again, I said stars; I saw something superimposed, and I made a guess that it was stars.

BRAND In general, I think it's a lot easier to see linear dunes than anything else, because your eye picks them up. Star dunes are rather hard to see at that altitude. Crescentic dunes are somewhere in between.

EL-BAZ Now, Deke was describing some stars or domes.

SLAYTON Yes, there were some interesting features in what I thought was China or Mongolia. We weren't too sure where we were, but there was something peculiar about that whole area; it just had a different appearance about it.

BREED In the transcript, it says "They look kind of like old domes; they're not stars and they're not linear either." I presumed that what you were talking about here was Africa, but you did see this sort of thing in China also? Something that looked like domes?

SLAYTON Yes, but I would have to go back and refresh my memory on that subject. I remember every time we came over there I was fairly sure that was where we were, because the mountains had a real black look about them and had a totally different overall appearance, than anything we saw anywhere else. I think that was in the area where I saw what I would term more of a dome-type pattern as opposed to the pure linears. I hope we've got some pictures in there; I don't know if we did or not.

EL-BAZ I think this mention of the domes was while you were running the DAC, between hills in Algeria.

BREED I wanted to ask you about one other phenomenon and that is the sand and dust storms that you saw.

SLAYTON The first pass we made over that area, I just had the feeling I was looking through a haze layer. So all I could conclude was it was either a very high thin cirrus (which I don't think it was) or it was a dust storm. It was definitely a fuzzy-looking phenomenon.

BREED You mentioned that it had a rolling appearance, a layered appearance. Could you see anything that looked like a regular pattern of rollers, a cellular sort of structure?

SLAYTON Not that I recollect. I just had a very positive conclusion in my mind, that was what I was looking at. I couldn't draw any other conclusion from it.

BREED Well, Bill Muehlberger brought along a copy of Science magazine and inside there is a picture of part of the Chinese Desert, the Takla Makan Desert, with a dust storm in progress.

MUEHLBERGER Now that's a storm pattern.

BREED I was wondering if you could see any of that pattern.

SLAYTON I don't recollect it.

BREED At your altitude then, it doesn't show up.

BRAND The only place I remember dust storms is around Aral Sea. Kazakhstan.

BREED Did you get any pictures of those dunes?

BRAND They were really obscured by the haziness.

STAFFORD It was late afternoon, but you could see the storm was really blowing; the wind was really blowing.

BRAND You asked about the color of the desert in the more southern parts of Africa, south of Egypt, mid-Africa. I think that

last shot showing the Oweinat Mountains was fairly representative of south of Egypt.

EL-BAZ Vance, are you talking about the strip of sand between the two hills?

BRAND It has some reddish tint to it but, by and large, it's fairly yellow.

EL-BAZ That strip of sand between the two hills is rather light colored, very light. So this was the color of the desert from Lake Chad all the way to Egypt?

SLAYTON It has that real light color track there, a river; then you have that darker stuff which you would expect around those mountains.

BREED Then there is a streak of windblown sand here and there are some dunes associated with it that you can't see too well.

BRAND Well, you have a fair amount of variation in the deserts down there, but I would say if you would take the lower right-hand one-fourth of that photograph, the colors there are fairly representative.

BREED Well, you can easily pick out the contrast here between the gravel plains and the windblown sand, because you don't get the oxidation.

BRAND I might say that the black mountains in that picture look much blacker in real life.

STAFFORD Yes, they sure did.

BRAND You just couldn't miss them. They really showed up.

BREED This illustrates very nicely too the barrier effect that you get between an outcrop of this sort and the beginning of a major sand deposit of that sort.

EL-BAZ One more question here. Vance, we thought that these things were igneous intrusions. What did you think? I know that you said something about volcanic nature.

BRAND Well, I know that it's always unsafe to draw big conclusions like this in geology, but they looked igneous to me. It looked to me like a big volcanic pile under the sand that had intrusions, many of which were circular and some were not. But it looked like the top of a mountain under the sand, and these were just some of the things coming up. I know that that's just an impression, but it looks like a lot bigger area of black rock than just what you see here. You think igneous because it's black, and you see structure.

BREED Okay, that's all I had, and thank you very much again. I think it was quite successful. You brought back a lot of good material.

EL-BAZ Doctor Robert Dietz has a few items on several structures and a few things that we have not seen yet.

DIETZ I want to cover both impact structures and some volcanic features. Regarding impact structures, there are two known types, and these give very close contract [sic] with lunar features. Among impact features are meteorite craters, the "type" example being the Arizona crater, Lonore in India, and some others; and I assume none of these were observed. They are all very small and probably outside your resolution unless you knew exactly where they were. The other type of feature is the astroplain [?]; these are the ancient impact scars, and you did obtain two of these. There is a third type which we think may exist; I'll mention it briefly. In 1908, there was the Tungusky event in Siberia caused by a comet head or possibly a carbonaceous chondrite, a friable meteorite that exploded in the upper atmosphere and blew down trees over a radius of 25 kilometers. Of course, you didn't see this; it's too far north. But it has occurred to some of us that in desert areas, particularly in the gravel plains or regs, that someday we might hope to find - we never have - a bleached stellate spot caused by some sort of upper atmospheric event of this type in one of the regs. These would turn over the gravels, which are desert varnished;

you should have a bleached stellate spot. Did you see anything like that at all? Let's go into the astroplains. One of the targets on the mission was the Sudbury Basin. This was not acquired. Another was of two features in Brazil, and one of these is in the first slide.

STAFFORD I could see it with my naked eye, but when I went again to the reflex, I couldn't see; so I just aimed down the barrel of the camera and shot. I'm glad we got it.

DIETZ I assume this wasn't adventitious, but you did see it and photograph it. Is that correct?

STAFFORD Yes, you could see it.

DIETZ This is in Goiás; it's the Serra de Canghala feature, or Packsaddle Mountain if we translate, a Mesozoic impact site. It's about 12 to 15 kilometers across the central dome and a ringed depression. I think it's remarkable that you were able to acquire it and to get this remarkable photograph of it.

STAFFORD From the spacecraft, I couldn't tell you that that was an impact. You could see the round structure; but as far as definition goes, I couldn't tell whether it was a volcano or something else. There was a circular structure, and I was scanning and I could see a kind of high cirrus in there.

And I suddenly picked it out and shot it. I had the 250-millimeter lens. I could see it with my naked eye, and I just aimed down the barrel and shot.

DIETZ Congratulations on it. A few minutes before this, over at Mato Grosso, there is even a larger feature which has more of a series of concentric rings, 40 kilometers across, the Araguania Dome. Did you see that?

STAFFORD Yes, I saw the two circular structures, and I think I shot at both of them. I'm not sure whether I got them.

El-BAZ There is one picture that we have right after this, but I could not see the circular structure in it. So this is the only one that we have identified yet.

STAFFORD I saw the other one. The other one was bigger than this, isn't it?

DIETZ It would be prior to this; it's to the southwest of this.

STAFFORD I remember I saw two; one was bigger than the other one.

EL-BAZ Was the big one not perfectly circular? Was it a little oval or ellipsoidal?

STAFFORD There was something about the rings that was more defined. The rings looked harder to me. I can't say whether it was

oblong, but it was bigger. Again, I tried to hit it with the 250-millimeter lens and I probably missed it. I was lucky to get this one. It was really frustrating to look through that lens and see nothing out there.

EL-BAZ It's amazing that we get a picture like this of a very small feature that's still centered.

DIETZ It's amazing and it's very difficult because generally there's a very high haze in the area, in the Chapada region just south of the Amazon lens. We really got a remarkable day in having a cloudfree day. As far as I know, I have this on ERTS, but I don't have any cloudfree images on ERTS, which is most remarkable.

Next slide. This is the Kupra [?] Oasis, and the circular spots are caused by a large pipe moving around once a week irrigating the ground. Near this, we have what is called the BP [?] structure, which is a known impact site with shock metamorphic effects. And that is located right there, you see. These features typically have a central dome and a ghost ring. You see, here is the central dome, and there is the ghost ring. This is also about 15 kilometers across. Right here, there is another part of a ring that looks like a twin site, which if it is, would be a new discovery. This hasn't been described. This is 130 kilometers or so up to

there. You see the central site, and you see the ghost ring. I haven't ever seen that ghost ring before in any ERTS images, so this is much better resolution. Further north is an even smaller circular ring, which is unnamed. Did you see that? It's another 50 kilometers further north.

EL-BAZ I don't think they would see this, Bob. This is mapping camera photography.

DIETZ This was not acquired for the circular structure?

EL-BAZ No, this was a continuous strip through the desert. Vance was looking through window 3, and this is from window 5.

SLAYTON In terms of resolution, though, that irrigated area down there and those circular things show up with no problem at all.

EL-BAZ Oh, you have seen that in flight?

SLAYTON Oh, yes. It's very easy to differentiate.

EL-BAZ I see.

DIETZ Well, this is a very fine slide and remarkable resolution of that feature, so it certainly is a plus to the mission. These are both two examples to be obtained of these astroplains, these ancient impact sites which are duomic scars

or roof structures which have been etched out by erosion. But they are very important. There are very few in the world, and they are very important to tie in with lunar geology. Next slide. Let's look now briefly at some volcanic features. This is Mexico in the area west of Puebla, and it shows a great many volcanic features. There are dike rings [?] and cinder cones, all acidic volcanism. You can see this little ash ring here; this is Topatszitl [?] crater; this is Los dasdurumbatos [?]; I studied this last February. But this is a remarkable sequence of volcanic features, in the Mexican central volcanic zone. I have no questions, but if there are any further comments, we can take those.

SLAYTON I think that is all very visible, again, very easy to see.

STAFFORD Yes.

EL-BAZ Who took this batch of pictures? They are a very nice stereopair of this site. Do you remember who took these pictures, to put them in sequence?

SLAYTON I think I took some through here, but I would have to go back and review.

BRAND I think, in this sequence, we had a couple of cameras going. We had the Nikon and we had a Hasselblad going.

EL-BAZ Okay.

DIETZ This is a fine view of the east end of the central volcanic zone of Mexico. Next slide. This is the Galapagos Islands. We see in here four or five large calderas. It's a most remarkable photograph, cloudwise and also geologically. Now I take it that when you're looking at Santa Isabela here.

STAFFORD You could look down and because of the Sun angle, you can see the shadows down in the calderas. You can see the depth.

DIETZ There's one, two, three, four calderas here. And this is a separate island nested in against Isabela; this is Fernandina, using the Spanish names, Ecuadorian names. Fernandina is probably the third most active region in the world after Hawaii and Iceland. Fernandina was seen to be in eruption on an earlier space mission. In 1968, it had a caldera collapse, the only one in history where the central parts subsided about 200 meters. My question is, did you see any activity here or any transients elsewhere in the world except Mount Etna, which you have and which is excellent, of course. Do you see any volcanic activity anywhere in the world?

SLAYTON I did as a matter of fact. We were flying over cloud cover, and we didn't know where we were as usual. But we saw something coming up out of those clouds that looked like an A-bomb to me. That was my first impression of it.

DIETZ Where was that now?

SLAYTON It was just a big mushroom thing. Well, we called the ground and gave them a GET; and a couple of hours later, they came back and said, we think you were about on the Aleutian chain. But this was an obvious big billowing cloud coming up through a lower cloud deck, and there was a big stream of gray-black smoke running downstream from it. And it had to be covering a 150 or 200 miles, probably more than that at least. We reported it to the ground, and I hope we got some pictures of it; we tried to anyway. Whether they came out I don't know. I have been very curious because I can't figure out what else it could possibly have been but a volcano.

STAFFORD We never saw anything else on the flight that compared with that, as far as smoke.

EL-BAZ We assume that it may have been an explosion anyway because this is a Soviet military testing site or range.

DIETZ We have not run this down. Volcanoes have neither fire nor smoke. They have ash and they have iridescent lava.

SLAYTON They do have smoke that goes with them.

DIETZ Not really smoke unless they're burning a log or something. What they have is ash clouds.

SLAYTON Right. That's what I assumed it was, an ash cloud. But it looked to me like it was a split cloud, actually. One part of it was gray-black and there was another stream running parallel to it coming out that was more white.

BRAND My impression was of the world's biggest grass fire, smoke cloud or something. It was a tremendous smoke cloud.

SLAYTON Would it be some classified event or something?

EL-BAZ It could very well be. Bill has suggested that he saw ...

MUEHLBERGER There's a strip at the end of the terminator and there was some gorgeous - I just thought they were thunderheads piling up in the background. Maybe that's why you took them. The things come right up out of the stratus and made a great big mushroom.

SLAYTON We took those, I think, down across southeast Asia.

STAFFORD This was blackish.

SLAYTON It stood out by itself.

DIETZ This area is uninhabited. It's a good example of what we can do from space because when something happens here, no one knows; it may be for 2 or 3 weeks or even months. So a place like this can be monitored from space. It's very important to know that, and I'm sorry you didn't get the Sudbury structure. I can understand why but if we find another Sudbury structure from space, we can hopefully justify the space mission economically because this dominates the world's nickel mines.

BRAND Just a comment; the first time we passed over Sudbury, there was too much cloud cover. The next time, it was a very oblique angle; we just couldn't see it, as I recall.

DIETZ I have no further comments.

EL-BAZ Very good, thank you. Bob? Now we'll go back to the ocean observations and we have Dr. Yentz to talk about the New England waters.

SLAYTON This goes with volcanics. We did have the three targets and I didn't see any of them. Mauna Loa was one of them that was clouded over. Mount Baker we did see and we didn't see anything.

EL-BAZ There was nothing at all on Mount Baker?

SLAYTON No.

STAFFORD In Guatemala there is supposed to be an active one, and it was clouded over. We couldn't see a thing.

EL-BAZ We are going to show some slides of the waters of the northeast coast of the U.S.

YENTZ These are mostly on revolutions that paralleled the coast. The first revolution starts when coming up the east coast of North America; its very conspicuous feature being the sunken river mouth and the coastal plain area where it enters Chesapeake Bay. It's a good example of a situation where the interaction of the fresh water outflow and the sea water inflow creates all the sedimentary patterns that are suspended in water, and I think that's the first slide. It's a very excellent ... slide. ERTS photography also has some very good slides of this sort. So let's move right on up the coast. The next conspicuous feature is the world's most famous sandspit, I guess - Cape Cod. Next slide, please. And that's a very excellent photograph of Cape Cod, Martha's Vineyard, Elizabeth Islands, coming off here, and Buzzards Bay in this area, Cape Cod Bay on the other side. The general problem of red tide in New England starts essentially

from this bay and extends up to the Gulf of Maine, into Canada. The next slide is a little bit better, or that's a better outline of the cape. Provincetown is in this region. The very shallow area is here; here are the deeper waters of Massachusetts Bay and you can see some of those little entrance channels and places of that sort. The next slide is a little bit broader shot of the entire coast. This is Cape Ann, which is the northern cape in Massachusetts, and the New Hampshire border is right there.

EL-BAZ Excuse me, Charlie. I would like to ask Deke a question. We have a report from the results of the 14 stations that were set up by the Commissioner of Public Health in the Commonwealth along the Massachusetts coast from Cape Cod to the south part of the Boston Harbor, through Gloucester and Cape Ann. They had a very high percentage of chlorophyll in the water near the coastline and that area in particular because there has been a lot of rain and the rivers brought in nutrients and chlorophyll and so on. Did you see any indications of that at all, Deke?

SLAYTON Well, it was obvious that there had been a lot of rain and had all that sedimentary stuff floating along the coast. I guess I'm not sure what you mean by chlorophyll.

EL-BAZ I mean it would have given the water near the coast a green tint. That comment never was sent up to you but it was supposed to have been. Along with the sediments you would have seen a greenish tint to the water at the coastline. You did not notice that?

SLAYTON Would it have been a greenish-tint boundary between the muddy water and the clear ocean water?

EL-BAZ That is right, yeah.

SLAYTON Well, thinking back on it, there probably was a little bit of that but I kind of assumed that that was just a phasing thing rather than having a clear-cut boundary where you have a little mixing going on between the fresh muddy water and the salt water.

EL-BAZ It could be mixing, but did you have the feeling that there was a greenish tint to that muddy water or the fresh water coming out?

SLAYTON I'd have to say I think so.

YENTZ Low-level haze almost rules out that kind of visual identification. Even from an airplane you have difficulty.

SLAYTON We certainly didn't get it on this pass. There was a couple of passes where we were a little oblique and we had a fairly good view in that area. I don't think we got any good pictures at that time.

EL-BAZ The ones that were taken of Cape Cod with the 250-millimeter lens. Those were the runs that you were supposed to take of Cape Cod and Cape Ann and so on. I bet that was the run that was good for viewing.

SLAYTON That run, as I remember, was clear around the Cape Cod area and then got cloudy as you got farther north. I think that's where we got the good Cape Cod pictures. I think it was a later pass where we got the stuff farther north.

YENTZ Yes, I think that's in the next slide, the shots of the Bay of Fundy. Next slide, please.

SLAYTON That's quite a bit farther north. I hope we got some in between there.

YENTZ This is Prince Edward Island. All of these red discolorations are really due to red clay. There are lots of deposits there and the high tidal activity keeps the water stirred up. It's kind of interesting to be able to follow these and see where the water clears up.

STAFFORD I didn't get much chance but it seems like those little things came out a little redder than what that photographed. It seemed like the redness of that stuff near there was more like a clay. Deke, what do you and Vance think?

BRAND There was a lot more contrast.

YENTZ I think maybe the next slide is a little bit better. Perhaps not.

SLAYTON That covers the area pretty good all right, but that's hazy too. It was a lot clearer eyeballed than that shows.

YENTZ The next slide gives a good example of the sort of organic outflows that I was telling you about. Now this is a totally different material. This is organic acid that's made by the heavy vegetation in these delta areas. This is the Orinoco River outflow and that is really a beautiful, beautiful section. I personally have been interested to know how far out you can detect this material.

STAFFORD We gave you a mark. It goes way out in the Atlantic.

BRAND Let me qualify one thing. You know we were talking about it all the way out there, to where the end of the brown water was; but later I kept watching and I decided that maybe we said it was a little too far out because you can detect a little bit of brown in sunglint.

EL-BAZ Tom, if we go by this we didn't know whether you were giving us the old GET or the new one. Do you remember? We were 2 minutes off or whatever because when we plotted that on the map it was way out in the Atlantic. Now can you remember, where was Barbados in relation?

STAFFORD Oh, it was past Barbados, because Deke got a stereopair of Barbados.

SLAYTON I took a whole series clear across here. On that run I think we went across Cuba and Bermuda. That pictures that whole area I hope.

EL-BAZ We have very good pictures of Jamaica, Cuba, and so on but we are talking about this discoloration in the water from the Orinoco River delta, whether it actually did go beyond Barbados.

SLAYTON Oh, yes. Barbados was in fairly close but I sure agree with Vance, because in the sunglint it does have a tendency to look a little tan or something. In any place, the Pacific or the Atlantic. But you could look out to the side and it even went way past Barbados.

EL-BAZ That's the question.

YENTZ To the oceanographer, this is a very interesting situation because this is like doing a huge dye experiment and putting it into the water and being able to trace it. It doesn't decompose very rapidly so that it takes on the characteristics of the water motion along the coast.

BRAND I think it was one of the most dramatic ocean effects we saw. It was really something.

SLAYTON Another one similar to that was off of the coast of China there where a river, is that the Yangtze, drains into the China Sea there. That was the same kind of a thing.

YENTZ Bob, one of the Chinese rivers has one of the highest loads, you were mentioning?

STEVENSON Yes, the Ganges has the highest sediment load, I think. But the Yangtze is way up there and so is the Orinoco. But the Amazon is quite clear.

YENTZ It's kind of interesting as sort of a sidelight that this yellow water going by Barbados is a signal to the fishermen out there to start up their flying fishing industry. It's kind of correlated, indicating that that does have some sort of a biological significance.

EL-BAZ Thank you very much. Now, Deke, getting back to your comments about the New England coastline. I don't think we have seen any pictures from about Cape Ann until you come to the northeast part of Maine. Unless it is in a magazine that has not been processed yet, we have not seen photographs of Boothbay Harbor.

SLAYTON The whole particular area was just about all clouded over. The one pass when we got the Cape Cod area was clouded over just north of there. But that's what I was thinking; maybe my geography is off a little bit. I thought we were getting Boothbay there in that area, that last one with all that coastal outline.

EL-BAZ It's farther north than that. That's the Bay of Fundy.

SLAYTON My geography was off and we never did get any good stuff done around the Cape.

EL-BAZ The comment that we wanted fed up to you was "on this particular pass, try to get a continuous strip all the way from Boston to New Brunswick." I think it was Crip that read the note and he emphasized the Boothbay Harbor, and you picked up the Boothbay Harbor or you thought it was at the Bay of Fundy because of all the sediment in the water.

SLAYTON I thought that we were in the Boothbay area there; we must have been farther north.

EL-BAZ It was a poor attitude.

SLAYTON We were kind of at an odd angle and I remember looking over it like this to see it.

EL-BAZ That attitude was not optimized for visual observations. We were piggybacking on some other attitude.

SLAYTON It was okay for looking. I could see fairly well, but I couldn't get any photography because it was a very oblique angle down through the window.

EL-BAZ But you don't recall whether you were looking down at Boothbay Harbor or not?

SLAYTON I thought I was, but I probably wasn't. That whole area up there was usually clouded over or at least large enough portions of it so that it was pretty hard to differentiate. I remember that one pass when I picked up Long Island; I thought I was already at Cape Cod and I shot some shots. I think we were really right on the edge of Long Island. We got a few pictures before we got to Cape Cod that should be on that same strip.

EL-BAZ Very good. Now, Bob Stevenson will continue with the additional ocean scenes.

STEVENSON I don't have a lot of specifics. I do have a couple, but I am more interested in your telling us the constraints that you felt in trying to find these features in the ocean and describe them in real time. We already heard from Tom, where he pointed out that the sun glitter comes in a hurry and disappears in a hurry. But in a more general way, you remember my point was "if you're up there and you're trying to describe the scene to either a tactical force on the surface or maybe even a fishing fleet on the surface." What were the constraints that you felt in trying to do this?

STAFFORD Well, the Sun angle to start with on certain features is really the dominant factor; say if there was no clouds as far as obscuring it, I think you can work it out. You know it really correlated with those flyovers you did over the West Coast. Those flyovers up and down that channel really helped. As far as the eddies and gyres, the big thing that outlined those to me, and I think to everybody else, were those little clouds right around the edges of them. You can really see that. And a current boundary, too. The clouds define it often. And I couldn't see any difference in the coloration - at least at Sun angles I looked down

at those eddies. Did you see any difference in the color? I couldn't see any difference in color.

BRAND Generally, you had a cloud rim which precluded you from doing that but if you tried and, if you looked at gaps in the cloud rim, you couldn't see a difference.

SLAYTON If you're asking how do you optimize Earth observations for the kind of things you are talking about, in my opinion we could talk about this among ourselves, too. I think we're at a very good altitude to do it but the penalty you pay for that altitude is a fast motion over the surface. The only way I know to beat that is to build yourself a nice big bubble off the side of your satellite here so you can sit right here in the bubble and you can look ahead and pick up what you want; and once you've got it, just track that thing right through until it's gone by. If you could do something like that you could get some phenomenal stuff. Even with all three of us working on things, we still had problems. Things just go so fast, there's no way you can sit and look at it and think about it and still take pictures. It's just impossible to do those two things in parallel.

BRAND And to go on further, suppose you have another problem, that of pinpointing where an eddy is. I always felt very uncomfortable because I'd see an eddy and I'd say, "Farouk and

Bob want to know where that is, I'll just give them the GET." But we can see for hundreds of miles all the way around. So while you're sitting in that bubble Deke's talking about, you need one of those eyeball gunsights or something so that you can look over there and say MARK and so you can get the azimuth off the guy's mask device or something. You also need to know the spacecraft attitude. You could, of course, give him a little sighting device to use, but he'd have to spend all his time getting that thing lined up and he would have wasted good viewing time.

STEVENSON I've gathered from what all of you have said that sighting devices at that altitude are really pretty useless and even maybe binoculars are not all that useful. You've got a good view, you can recognize thoroughly. Tom mentioned he saw 15 ships coming out of Gibraltar at least.

STAFFORD Oh, you could see them down there.

STEVENSON So with the visual acuity of even fairly small objects, there's no problem that I can see there.

BRAND In midocean, you can plan on getting most of your data from clouds and only once in a while getting it from sunglint when you are especially lucky.

STEVENSON I also gather that you felt much more comfortable in observing and trying to describe the scene rather than trying to photograph or point at the same time. is that right?

SLAYTON Say you've got an objective of taking a stereo tree of an object. If you do that right, that takes you 15 seconds. By the time you get in to where you can really shoot that thing and use 15 seconds, it's gone. And you haven't looked at it.

BRAND They're starting to do one or the other.

SLAYTON They asked us to comment on a lot of these pictures. There isn't any way to do it because, if we got you good pictures, we didn't really see it.

STEVENSON That's right.

BRAND And comments may come easily one time and hard the next. For example, you may see something that you can describe very well. You may say, "I see a circular cloud structure and I can see that it's 20 kilometers across the MARK, the time I see it as such and such." And you can describe the color maybe. The next time you may come up on sunglitter, you'll see a pattern, you'll see a gyre perhaps in there. And there's no way you can describe that, and you wish you

had taken a picture or you'll wish that you had a pad that you could draw on to fill in. For instance, if you had an outline of Puget Sound showing Seattle and two or three prominent landmarks and a pencil in your hand, you could draw in what you see. You need something like that.

YENTZ You also need the Maine coastline already predrawn.

BRAND Yes.

SPEAKER What you need is outline maps?

BRAND Yes. Because there are times when the flight planners have you hitting several sites in a row, too, and you don't have time to do that sketch and so you say to yourself, "I don't have time to debrief this one; I'll debrief all five of them when I finish." And then you get to the end of that and you're coming up on the next event and you don't have time to spend 10 minutes debriefing things that you've partially already forgotten. These are all problems.

EL-BAZ We should have kept you up there for a couple of months so you would get a couple of chances?

BRAND You need repeated passes over things too because if you have one pass, there's a good chance that something will be bad. But if you have three or four passes, you've got a very good

chance of getting a lot of data on it, or if you have two passes even. And you shouldn't be very oblique. If you're oblique, that's tough.

STEVENSON Unless it's a major feature.

BRAND Well, yes. Maybe a series of gyres going off to the horizon. That's okay, but if you're wanting to get Puget Sound, you'd best be right over it.

STEVENSON But now, the first observation pass was the day after launch, about 26 hours or something like this, coming up across New Zealand. With New Zealand's cloud cover, you didn't see Cook Strait.

BRAND That's right.

STEVENSON Okay. But it was the first time that you really seriously looked out other than to maybe occasionally say, "There's the passing scene." Can you think back through all of the events and then think ahead maybe after the undocking when you then began to do visual observations again, do you feel more confident as this mission went on?

BRAND There's a learning curve.

SLAYTON I think, again, it was the time constraint. Speaking for myself, I had a couple of passes early during the joint

operations period which was our only chance to get it (that one rev) and we knew we were going to be busy through there but as usual we were about four times busier then we really expected to be. We just felt like we didn't really have time to properly prepare for it, we didn't do it right, we were just up against the stops all the way on these early ones. I don't think we did very well on them at all. Once we got through the joint activity period, where we could all three work the problem together, help the guy that had the primary task by looking out the window and we changed our attitude, I think we got reasonably good results from then on. But I frankly think that anything we did prior to that was not very good. If it was, we were just lucky. I think, on the other hand, if we are talking about 5 years from now and you want to do Earth observations from a space station; if that was one of your objectives, we could build a beautiful Earth observation module that you could do a super job with. You could couple in this great visibility along with a couple of hand controllers. You could tie all your bank of cameras in and a couple of push buttons here to select a 250 there and an IR here, and get some beautiful stuff. That's what the Shuttle's all about, isn't it?

BRAND Man's greatest utility up there is as an identifier of sights and the way this eyeball can be used to describe things, but he can be very useful in pointing things. And then describe them, maybe in addition.

SLAYTON You can discriminate and you can pick the right thing to do the right job for you in real time and do it fast. I think that's the big thing.

STAFFORD You'd also like to have this observation device in a heads-up reference, too. I think that's been pointed out before.

SLAYTON If a person is out there in a big bubble, so he can pick his own attitude, he can't go wrong.

STEVENSON Now do you think it's useful to consider some kind of device that instantaneously tells you where you are or what part of the Earth you are over? Many times you say, "Where am I?"

STAFFORD You could have a data printout.

SLAYTON We had this thing onboard which we never got around to using. We thought about it a few times but it's one of those things you have to update to be valuable. We had the other map that we did pull out and stuck up here; we kept referring to that and that was very helpful once we got it out and used it. You'd be surprised how many times you'd come up

over a coastline and you wouldn't have the vaguest notion whether you were over Africa or Australia or the U.S.

STEVENSON Mainly because you haven't been doing visual turns all along.

SLAYTON You're wrapped around the axle with crystal growth, or something.

EL-BAZ Is this the map that you are referring to?

BRAND That's a good map.

STAFFORD That's a good one. The only thing you might do though; all the numbers are down at the bottom. They need to be up at the top too because you have to start way down here and turn the map over and thumb over to here.

SLAYTON That's why I think this would be good if we'd ever had a chance to get it updated and use it. Also, we got the time ticks on it.

BRAND Deke mentioned the time ticks. I think it might have been good enough to put just some representative curve on there showing representative time ticks that you could translate to any one of those curves. You could take your finger and say well this is 6 minutes.

SLAYTON You could look at that quick and say "Well, I got 10 minutes from Hawaii to the West Coast."

BRAND Something like that if it were kind of automated so you had a quick visual reference without manhandling anything.

STEVENSON Well, you're talking now about the Soyuz ball or the Mercury ball.

SLAYTON We had one on Mercury that did exactly that. It was an old clock globe. All you did was wind it and turn it on and put in the right coordinates at the right time. It was a little gross, but it pretty well did the same thing. You could refine that.

STAFFORD Well, with the data displays that you're going to have on the Shuttle, the CRT's that we have now you could have them read out a latitude and longitude in just continuous strip on the thing.

BRAND I must say though, that a ball is much quicker. There are some times when I think of 159 west, that doesn't mean much to me.

STAFFORD You don't need it in the basic cockpit, but for the Earth observations it would really be handy to have that.

STEVENSON So inside the bubble or on the bulkhead of the bubble where the guy is going to be sitting, you've got this ready reference, right?

BRAND And we talked also about how do you mechanize the bubble. Tom suggested a big mirror and Deke and I were also thinking of perhaps, instead of a mirror, a tracking arrangement where the whole seat would move like a turret or something. If you really wanted to get exotic, you could just go to the end of the world on fancy devices.

SLAYTON You put the bubble on an arm and you got a hand controller. Just fly the thing around and you're tracking through the whole arc.

BRAND It might be done either way.

SLAYTON Work it like a turret.

BRAND Like a ball turret.

EL-BAZ Are you guys going to write a note on this?

BRAND I think Bill Pogue is working on something like that as a matter of fact right now. Perhaps he could incorporate some of our ideas.

STEVENSON In some of the observations, and I guess I'm now thinking of the ones that you made Tom of the front off Spain as you were coming up. All of a sudden it comes up. There it is and this is great. At least we know it's there. If you were placed in a position of having to give some sort of ready reference as to where it was physically located, that would not have been a problem. In other words, here you saw this front and all the internal waves. The only place for this kind of reference of magnitude or location would be when you're well away from any coastline or any island or anything of this sort, where you're really not sure where you are.

SLAYTON Not quite. I was looking out at some islands down here in the south; we weren't sure where we were, just shooting some "gee whiz" pictures and all of a sudden I'm in sun-glint and there were some internal waves right along these islands and we didn't have the vaguest notion where we were. And it turned out we were down around New Guinea, somewhere in there. But we had to call the ground and ask them. We didn't know. I don't know whether those pictures came out or not either.

EL-BAZ Yes, them came out.

STEVENSON Yes, those were spectacular. Those are the ones with the 35-millimeter camera.

STEVENSON Yes, I think Dick Underwood needs to sit down with you gentlemen. Where were you when you took this picture? Or what were you doing other than taking pictures? Okay, I need one more thing before we look at some pictures. Again I would rather have your opinions right now, as you recall, of the problems and the constraints in some detail. But this one early in the mission, revolution 17 again, and Vance saw a scum line. Do you want to discourse some on that scum line? Can you remember it?

BRAND Let's see, am I right in thinking that I'd just passed over New Zealand?

STEVENSON That's right.

BRAND There were a lot of clouds over New Zealand, I remember the mountains sticking up through the clouds, and I guess what I was looking for was a red tide, or plankton blooms.

STEVENSON Yes, you said, "I don't think it's the time of year for plankton; looks too cold down there." Real objective.

BRAND All I can say is that I was looking for plankton blooms, and I saw a line beyond the island that did not look like

it was vegetation. I mean it did not look like it was biological, and I think that is why I asked. You do see occasionally, especially from airplanes, trash lines on the water. And it was kind of a dark, wavy line, and that's about all I can give you.

STEVENSON The thing that's making me wonder are data of the New Zealand air crew on that day. Here's their cloud-line flight-line plot from New Zealand going northeast. They plotted the cloud types and roughly their heights, every few minutes. So this is about two-thirds of the way out the line; the line was 400 miles long, so let's say this is like 250 miles north of East Cape. So you're beyond the islands and the clouds, presumably, are reasonably broken out there, very scattered, and they got this very distinct discontinuity in the water. Distinct change in wave heights; so the appearance of the sea should have changed.

BRAND It should have changed in color or texture on either side of this line?

STEVENSON Texture. But, you see, if it did change, also in the motion of the water, this could have been a scum line.

BRAND All I can say, Bob, is that I don't recall so much a textural or a color difference in the sea but I do remember seeing this line.

STEVENSON And it was beyond the islands, clearly?

BRAND Yes.

STEVENSON Not immediately adjacent?

BRAND That's correct. And at our altitude we didn't really see texture and color differences unless the light was just right.

STEVENSON But if you're going to see a scum line, it's going to be a fairly sizable feature.

BRAND Yes. I agree.

STEVENSON It's not going to be one of these Galveston Bay scum lines. Or something maybe that isn't too wide but it's long. So thinking back, that's kind of what you think you saw, long linear feature.

SLAYTON It would not have to be too wide because we could differentiate roads.

BRAND That's right. It wouldn't have to be very wide.

STAFFORD Was that the area where we looked down and it looked like, something like plankton but it was probably sedimentary out east or northeast of New Zealand, or some place. We were describing and said, "Is that plankton or is that sediment?"

EL-BAZ "Or is that bottom?" I remember that. You were talking about that maybe you were seeing bottom because it was a little greenish, and maybe that's not plankton bloom because you were seeing bottom.

BRAND We did see bottom, we're pretty sure.

EL-BAZ But then this is farther off the island; there are pictures of something that looks like plankton bloom. I think we have the slides.

SPEAKER Frame 37. About the time you were talking about the scum, you got this nice big bloom.

STEVENSON But again that's reasonably close to shore, if that's the one I'm thinking about. Right? Because the frame immediately before showed the shoreline and then you could see part of that feature.

BRAND Later on it might be helpful to look at the pictures. That would trigger our memory.

EL-BAZ We do have some pictures.

STEVENSON Right in that area, here's the sound velocity profile. You can see the low velocities jammed up toward the surface there. Sometime later we'll go through the photographs and we can go back through this. That's the kind of features

we like. Deke, you mentioned that you, north of Hawaii, came past Hawaii and one day saw all the eddies standing out about 200 miles long, you thought, south of Hawaii. Just a minute or so later, you saw linear cloud lines and you mentioned what you thought looked like a big front in the ocean. Can you describe that a little bit?

EL-BAZ We have the pictures of that, Bob, at the end. We have the picture of the front. The mapping camera was photographing at this time, and we do have the slides.

STEVENSON I don't think it was contrast.

SLAYTON I don't have any more comment on it.

BRAND I took the pictures and remember it fairly well. It was just weird. I'd never seen anything like it before, it was a tic-tac-toe type pattern.

EL-BAZ We're talking about two different things now. You're talking about the highways? I was talking about the bunch of eddies, or Bènard cells, or whatever they may be, and then a very solid front of clouds. Right?

SLAYTON Yes, I remember that when we discussed that, and I saw it. The cloud pattern was unusual; one was one way and one was another coming into it or something.

EL-BAZ We have the pictures.

BRAND Oh, I remember now. Part of it was circular and it had a linear thing coming into it.

SLAYTON Yes, there was something linear going into it.

BRAND I think you would have to rely on the tape, whatever we said.

STEVENSON We don't have that part of the tape yet.

EL-BAZ We don't have the tapes of the latter part of the mission; we're still looking for them.

STEVENSON This was a real-time transmission you made, Deke. You said, "Hey, gee there's a big front down there." And you mentioned that it looked as if there were turbulent eddies along the boundaries. And that's all we got so far. I don't know if there's a picture; I haven't seen a picture.

EL-BAZ As we go through the pictures, maybe that will remind them.

SLAYTON I can't tell you any more off the top of my head. We saw so many interesting cloud features over that ocean you can't believe it. If we had about another 500 frames of 70-millimeter film we'd have shot her up over there, but we thought we were running short and we were holding our horses. There were all kinds of interesting clouds.

BRAND Infinite variety of patterns.

STEVENSON Okay, one last general question. I have already talked to Vance about it, but maybe Tom and Deke can remember the last day. Was it revolution 136, the one across the North Atlantic? At the end of that revolution you all looked out and saw the green Ireland. You mentioned Ireland really is green, that you could see it through the breaks. Okay, that was the RAF pass; on most of that pass, the Nimrod crew had 100 percent cloud cover out to 400 miles west, and then they got into some broken scattered clouds. And they did see some distinct changes in water color. So my main question is this: Looking through that kind of cloud cover, what sort of comments can you make about looking at the ocean through that kind of stuff? Do you remember seeing anything other than the fact that there were breaks in the clouds?

SLAYTON As I recollect that particular pass, we were pretty much over cloud cover for an extended period of time and all of a sudden we found this break, and there was that green down there and we figured, trajectorywise, that would be about where Ireland was. And as a matter of fact we then saw southern England, and on into France and then we picked up some more cloud cover through middle Europe again. I think it was pretty solid overcast before that.

STEVENSON So when the clouds do open up, even reasonably good, then are you not prepared, or are you saying, "It's pretty solid?"

SLAYTON I think you can tell pretty well, when you are looking out, when you are getting enough breaks in it so you expect to see something. But when you have something like five-tenths cloud cover, you don't see very much obliquely. If you're looking straight down through them, you can pick up some definition.

BRAND The shadows don't help the situation at all, in the clouds.

STEVENSON White caps.

STAFFORD You don't really see white caps too much.

BRAND No.

SPEAKER When you've got that many clouds, your geographic orientation is going to be poor, too.

BRAND That's right.

STAFFORD We sure saw some icebergs though, up in that North Atlantic.

SLAYTON Did you ever get a picture of that?

EL-BAZ In the 35-millimeter, yes, there are some pictures.

SLAYTON There was that one iceberg sticking right up through that cloud deck, or fog deck, that was leaving that wake right behind it. Spectacular.

EL-BAZ There was a picture of some icebergs, one big one and maybe a few small ones, with not a speck of clouds.

STAFFORD There was one you could see the tip of the iceberg, and it looked like a shockwave behind it. There were clouds flowing behind it. It was just a "V", like this. And here's the iceberg sticking up through it and the clouds were flowing like that.

EL-BAZ Okay, I haven't seen that.

STAFFORD I hope it came out.

STEVENSON No white caps though? You don't remember seeing any white caps.

SLAYTON I don't know, maybe around some - -

STAFFORD You could sure see the wakes of ships though. Those will really stand out.

SLAYTON Maybe on some shorelines you might have seen the surf.

STAFFORD Yes, possibly, but I can't remember identifying it. The main thing are the wakes of ships.

SLAYTON At least, that's where it ought to be, but whether we're actually seeing it or not -

BRAND I think you would have to see it as textural difference, rather than white caps.

SLAYTON Yes, right.

STEVENSON Let's quickly run through these slides. Now I think that this is the one that everyone is talking about off New Zealand.

SLAYTON Yes, that's it. That light material is what we're talking about. Is it sediment or is it plankton or bottom?

STEVENSON Let's go to the next one, because that's the same feature. Now that's not your scumline. That must have been a different camera or different lens.

SPEAKER No, this is taken I think about 4 minutes later. He was almost to Cook Islands when he took this.

STEVENSON But that's the same feature there, or something. Can you back that one up? There it is.

SLAYTON That's the same feature.

SPEAKER There's four frames in between, though.

SLAYTON Okay, you had to change lenses to get that difference.

EL-BAZ You have to change lenses and we had one mapping camera busy, and we could not have been using two cameras either.

SLAYTON But there was stuff like this out to the northeast of New Zealand.

SPEAKER This camera doesn't have a Reseau plate on it.

STEVENSON Okay, let's go to that next one then.

SLAYTON Has that got a Reseau on it?

EL-BAZ It's the same pattern, but it cannot be the same feature, because we had one camera going. And there are several frames between the one we saw and this one.

SLAYTON That has to be 250-millimeter lens there to have the same scale effect.

BRAND We didn't change lenses.

SLAYTON We sure didn't change lenses that fast.

STEVENSON Okay, the next slide, please.

STAFFORD Hey, there's some with internal waves.

STEVENSON And I'm guessing that these are the internal waves you saw.

SLAYTON Yes, sir.

EL-BAZ Very nice. Is this the same view? Do you remember it?

SLAYTON Yes, exactly. I may be wrong, but that was my immediate impression, that those were internal waves, and I shot them. I don't know if you guys agree if that's what they are or not.

STEVENSON I think there's no doubt about that.

SLAYTON They're certainly very big structures.

STEVENSON So as you came across this field of view, you got a glitter pattern and there's the internal waves.

SLAYTON That's what I mean about them just springing out at you all of a sudden. We were just kind of cruising along there enjoying the scenery and all of a sudden, there they were.

STEVENSON So you have, about 5 seconds, you think?

SLAYTON Probably.

STEVENSON So if you're going to say anything about it, you're not going to shoot a picture.

SLAYTON That's right.

STEVENSON Okay, the next slide.

STAFFORD That's the Mediterranean. There it is.

STEVENSON Now, if you can remember before the mission, there was a Skylab shot, and in that shot that front was lying right opposite that river mouth. Now you were coming up on a path roughly about so.

STAFFORD Yes, up to the north, because we were right by a big flight-line that runs from Spain.

STEVENSON And you also looked over here. Now is this where you saw the ship's wakes?

STAFFORD Right in that area, right there.

BRAND I saw those too.

STEVENSON So the glitter pattern then came moving this way toward you. Is that right?

STAFFORD No, this way.

STEVENSON So you saw this feature first?

STAFFORD At first, it was just a solid shade of blue, nothing there. Suddenly it just popped like that.

EL-BAZ And you noticed that we have not seen these ships or the ship wakes in the pictures.

SPEAKER There's no glitter picture down in there.

STAFFORD But you can see ship wakes if you don't have glitter, too.

BRAND You can, yes.

SLAYTON You're right.

EL-BAZ They were looking at ship wakes before they got the glitter there.

STAFFORD And these ships are like little white dots all down in there.

STEVENSON Yes, that's a beauty; there's no question about that.

EL-BAZ Bob, what's this dark water, or is this the boundary between the two currents?

STEVENSON There's a distinct difference in the motion of the water on either side of the boundary. You see rougher water on one side than you have on the other, and it makes a difference in the reflective pattern. You can see the slicks. Tom, that's the first thing that struck your eye, I guess.

STAFFORD Yes. The whole contrast looked like it had a gyre spinning off of something out there too. I shot a bunch of them right in this whole area. There were also some internal waves that were coming out someway. We have a couple of other shots that we could look at individually, later.

STEVENSON Boy, that scene comes pretty fast for you to describe all the features you saw, right?

STAFFORD Yes, it does.

STEVENSON Next slide, please.

STAFFORD That's Sicily. You can see those waves. That's the south-east coast.

STEVENSON Now you mentioned the cloud line several times, and I'm guessing that this is it.

STAFFORD That's what it is. You can see it's superimposed on top of a wave right there.

STEVENSON So that was fairly easy to see, I guess.

El-BAZ This was very clear on the TV that we saw during the undocking. That was a beautiful line right there.

STEVENSON Yes, at the undocking and the redocking there was a fantastic cloud line. Are those cloud lines helpful as you come up on them and as you get into a glitter pattern and then begin to see the features behind?

STAFFORD You can do a lot with clouds as far as giving some clue.

STEVENSON The Mediterranean was mainly clear from all I remember during the flight. And you did look at it several times, and there weren't a lot of clouds, but still the features stood out, did they?

SLAYTON We were coming down across the other way through, it seemed to me. Of course, that's most of the Adriatic, but that was pretty well clouded over, in the eastern Mediterranean.

STAFFORD That was a descending pass where this was kind of ascending.

SLAYTON Ascending passes seemed to be clear. When you're trying to get that stuff - -

BRAND When we were trying to that Adriatic Sea stuff, we had a lot of clouds over the Alps. It seems to me we had them over the Balkans, and down to Venice and then it would clear out over the water.

STAFFORD The Alps also had a lot of haze up in the air, haze and clouds. We got some of the surroundings, you could see some of the snowline, but it was just very hazy there.

EL-BAZ Was it air pollution in little areas and valleys and so on, or the whole thing?

STAFFORD No, the whole thing was pretty hazy.

SPEAKER Was there any more, or was that all the slides?

STAFFORD Here are some cells. We used to see those every once in a while.

STEVENSON That's in the mid-Pacific, right?

BRAND Generally, you didn't see so many cells.

STAFFORD They were bigger and fewer, weren't they?

BRAND Yes, in all different sizes.

SPEAKER Was that all clouds?

STEVENSON It's cloud, these are convective cells over the Pacific. It's a fairly constant feature of the tropical ocean, at least in that area.

SPEAKER Bob, about your internal waves off New Zealand. Now, the internal wave has to be normal to wind direction at speeds less than about 11 miles per hour, or 13 miles per hour, otherwise you have Langmuir circulation and your slicks run parallel to wind direction.

STEVENSON That's right.

SPEAKER Off Brazil, which is it, internal waves, or Langmuir circulation or do you know?

STEVENSON In that photograph we saw, I think there's no question that it was internal waves. I can show you some Langmuir circulation and it doesn't have anywhere near that appearance, from that altitude.

SPEAKER But it was off New Guinea.

STEVENSON I think the next slide has another cell. And that's a 35-millimeter shot and my guess is that, Deke, you took that. You mentioned that you didn't usually see so many cells together and here's one that's pretty isolated. So I guess my question is, "Is this fairly common?"

SLAYTON Yes, very common. And many of them were exactly like that, they have a fairly large cloud structure on one side and then there was kind of lower clouds around the rest of the rim.

STEVENSON Are those easy to pick up?

SLAYTON Yes.

BRAND No problem.

STEVENSON I have one more question, which is really for the whole crew. We were hoping you were going to see some bioluminescence. I remember on that one pass when Deke said, "Hey, somebody goofed up; it's still daylight here."

SLAYTON We were in daylight; the ground was in dark. But once we got the spacecraft into the darkness, there was a cloud cover, I'd have to guess. I could see oil fires burning up through there, but it was obvious from that that there was somewhere between five and eight tenths cloud cover and I couldn't even tell where water was, to say nothing about where bioluminescence might have been.

STEVENSON So you never had any during the whole flight?

SLAYTON No, sir. If it had been clear as a bell down there and it, in fact, existed, our odds of seeing it were pretty poor, I think, because we'd just come out of that bright sunlight and suddenly you're in the dark and no dark-adaptation time at all.

BRAND If you ever try that again, you'd really want to have a long dark-adaptation time, and you'd want to think about moonlight and things like that too. That moonlight has quite a big effect on what you can see.

STEVENSON You had a good Moon.

BRAND Yes.

STEVENSON I have one more thing to say. As you remember, the Chief of Naval Research, Admiral Dick VanOrden, came down here

prior to the mission and you guys were all on simulation that day, so he didn't get to see you. The Office of Naval Research considers this whole effort to be of extreme significance to their research program as well as to future Navy operations. The admiral has since retired, as of August 1, and he wanted me to extend his best wishes to all of you and thank you for your efforts. He has had put together some certificates which on his behalf I'd like to present to you now.

EL-BAZ We have maybe 5 to 10 minutes more with a few more pictures of the clouds and meteorology. Unfortunately Pete Black cannot be here today, but we'll show some of the slides that he wanted to talk about. Look at a couple of cloud patterns and here, Bob, this is one of those places where you have in the Pacific these tremendous Bènard cells or the cells of clouds; then you get to that edge of the cloud front. I think Vance also commented about that and so did Deke; that in the Pacific and for miles ahead of these you had these separate patterns.

BRAND We ought to really sort out Bènard cells from what we're calling eddies. I guess those look like Bènard cells. But the things that we're calling eddies are bigger features, not all of the same diameter, and sometimes scattered.

EL-BAZ Can you see a few of them? There are not as many as what you see right here?

BRAND Sometimes you'll see only one. Or you may see three, but in kind of random groupings.

STAFFORD I remember one time, we looked obliquely and these were great big things, but they went practically all the way to the horizon, like one, and here's another one, and disappeared. We're talking about maybe four cells, eddies total.

EL-BAZ So the stuff that you were describing, Vance, near Hawaii, was it like this, or like what you think the eddies may be, the fewer?

BRAND It was not like this because this is an area of cells. What I saw was a line of circular structures going to the horizon. And it occurred to me that perhaps it was the edge of a current, but then I couldn't justify that idea, because it didn't look like gyres, or spinoffs. It looked like pure circular cells, more or less in a line.

STAFFORD But it did look like you were following a meandering current that was going off across the ocean, didn't it? If you were going to try to establish a pattern to it.

BRAND It looked like it followed a boundary.

STAFFORD Yes.

EL-BAZ Okay, good. Next slide please. Okay, here's your highways in the sky, a very fantastic picture. Some people have said that these may be contrails and you said they are a little too big to be this way. And I think we had comments coming from some of the Skylab guys, that they had seen these linear patterns in the clouds before, but this is a very dramatic one.

SLAYTON We saw an awful lot of contrails over the North Atlantic and it's nothing like that. They just don't get that big.

STAFFORD That's right. They were lots thinner than that.

BRAND When you look at this in a picture, you say, "Obviously that's contrails," but when you remember back to how wide they were, at the bases - -

STAFFORD You see that little thing right there? That's more like the size of a contrail, at the maximum. That would be a big contrail right there.

BRAND Contrails were lines; these are wedges practically.

STAFFORD Also, it was interesting in the way that this pattern stopped.

BRAND I'm not sure. At the time I didn't think so.

EL-BAZ That's very good, next slide.

SPEAKER Remember from Skylab, when they took a picture and they thought it was the hot air coming from a ship going through a very low scattered deck about like that, and there was a plume going right across the apparent trend of the clouds. Do you think that maybe that was this same thing?

BRAND It's a possibility I suppose but at the time it looked natural.

SPEAKER Did you get any perception of depth on it? Or did it look like it was all of the same depth?

BRAND More or less the same depth.

SPEAKER Especially the two that crossed?

EL-BAZ Can we get that slide back for a minute?

SPEAKER They didn't look as wide.

BRAND Let me say this, the base of the wedge was extremely wide, I'd say miles and miles. Now do you think there's anything natural that would give that width of I don't know how many miles?

SLAYTON You could put a scaling factor on that.

BRAND It could be determined. Perhaps 10 or 20 miles. Would a contrail or ship's wake do that?

STAFFORD Here's something else. Is it because of sun heating that down below this is all blue and the discontinuity?

EL-BAZ Okay, I think we'll have to leave this to meteorologists and we'll see what comes out. This is one very good picture or the convective thunderstorms or thunderclouds. You were aware of these things as they went by, the difference, the distinctive difference?

STAFFORD We got a bunch of those in various places too, but I don't know how they came out.

BRAND That's very typical.

EL-BAZ This is a typical view, is it? Very good.

BRAND We've seen just scads of those.

EL-BAZ And this is just the right exposure for the meteorologists because they can see the texture in all the cloud here. This is what they would like to see in cloud pictures.

STAFFORD We lucked out, this is going into sunset.

EL-BAZ So, to me, I thought it would be a very underexposed picture, but this is the way they like it so that they can start seeing the texture in the cloud. Next slide, please.

SLAYTON Most of them that we shot intentionally were probably overexposed.

EL-BAZ What's this one, Vance?

BRAND I believe that was an attempt to show an eddy.

EL-BAZ This is not the developing storm?

BRAND No. The one that was developing was so big that if we had taken a picture of the center of it, all you'd see was white on that frame.

EL-BAZ The developing one, the one that you got at the very end of the mission?

BRAND Yes, it took minutes to cross it.

STAFFORD Yes, hundreds of miles across that bear.

SLAYTON We had to shoot a panorama through almost 180 degrees to cover that whole thing.

STAFFORD That's it, that's the one.

EL-BAZ And why did they call this developing? That has a very good movement to it.

BRAND It looked like a hurricane, it really did; it had spiral arms. The only thing is you didn't see the eye in the center, but you saw things that could have been the eye covered over, or you saw something that you could imagine that's where the eye was.

STAFFORD Yes, out of focus.

STEVENSON Do you remember where that previous slide was taken, Vance?

BRAND I think I called down a MARK; I tried to on all these; tried to give a GET. All I can say is that I'm sure it was the Pacific and can we switch back to it?

EL-BAZ You had five very nice pictures in that sequence of it; we have magnificent stereo.

BRAND I think that's a very good picture of what we call an eddy.

EL-BAZ Okay.

STAFFORD The earlier one.

BRAND The one before this.

STAFFORD Yes. That's what we term an eddy.

BRAND Now you can see on the bottom of that structure a continuation around, and clouds on the edge that are normally

cumulus-type buildups, but not going very high. Sometimes in the center there are clouds, like you see; and sometimes in the center, no clouds at all.

STAFFORD Often, I'd say at least 50 percent of the time, the center had no clouds at all.

SLAYTON I thought that was the difference between a cold- and warm-water eddy. Off the top of my head, I'd say that was a warm-water eddy and the clear ones were cold-water eddies. I don't know if that's right or not.

SPEAKER I think you're right.

SPEAKER I'm convinced that's warm water and if it is where I think it is, it's a perfect representation.

SLAYTON That was what I said about all those.

EL-BAZ Okay, very good. Next slide. We have a couple of pictures here. Is this a ship wake or an oil slick? This I think is in the gulf. We may go through this sequence in detail and see.

STAFFORD Often you would see stuff like this over here, and I don't remember seeing that. Does somebody remember seeing it? We just lucked out and got it.

SLAYTON I remember, once coming across the gulf, that we did see what I thought was a pretty clear boundary line there, but whether that's it or not, I frankly don't remember.

STAFFORD That's right in the Gulf of Mexico. There was a boundary line. Down here.

EL-BAZ Okay, the next one please.

STAFFORD That looks like part of the Amazon Basin. See that river? That's the Amazon Basin.

EL-BAZ Okay.

STAFFORD That's interesting, because we haven't brought that out before, but in part of that Amazon Basin, what I thought was the main Amazon River, was real brown muddy water; it stood out just like a brown line running through the green jungle. Then there were some rivers to the north of there, and this is one of them, I think, that was clear bright blue, nice clean looking water.

EL-BAZ North of the Amazon?

STAFFORD I never was sure whether it fed into the Amazon as a tributary or not.

SPEAKER The part which is dirty comes from the Andes and you have clear water coming in north and south. The dirt from the south is very black because it's high in humic acids. The Rio Negro is called Negro not because it's muddy, but because it's high in humic acids. It's very black.

BRAND Where we saw those two rivers come together, it was jungle and it looks strange to see the water look clear, going through jungle terrain.

EL-BAZ Okay, very good. Here are a couple more pictures that we don't know the location of. Next slide, please. This one we have an idea about, but we're not really sure. You see, this is snow cover on top of the mountains, and see the solid cloud.

STAFFORD That could be the Andes but I don't remember any thing detached like that in this other thing.

SLAYTON It could be the Himalayas. One pass we made over there. it was all cloud covered and I just remember we had a few sticking out the top there once.

EL-BAZ You could see things sticking out through the clouds?

SLAYTON Whether that's it or not, I don't remember.

EL-BAZ We'll come back to this, maybe. This one is the same little detached piece. And that's low Sun angle and most likely it is the Andes, because of the geometry. Do you remember, Tom, when you had two revolutions at the southwest over South America (one of them revolution 88 and the other about 120)? Maybe one of the revolutions was where the clouds came all the way up to the mountain, where you did not see a coastline, where you could not see the Nazca Plains.

STAFFORD That could be it. It would be on the earlier pass. On the second pass, the clouds were not as - -

EL-BAZ Did not keep to the mountain. These is very low Sun, so that's why I'm saying it is the Andes.

SPEAKER Between Concepcion and Santiago is this detached mountain range that goes up almost 9000 feet off the main Andes. At the lower right corner, Santiago would be under those clouds.

STAFFORD You think the last one was over that same area, too?

EL-BAZ It's the same area. Go back to the last slide.

SPEAKER You can see those Argentine sand dunes in the background.

STAFFORD Okay there they are. So the Pacific Ocean is down here at the bottom? That's the Andes. They have a kind of peculiar characteristic of their own.

EL-BAZ Very good, and then the last slide, please. That's about the only one that I recall with an iceberg in it. I don't know whether these white pieces are also ice pieces or not.

STAFFORD Is that with a 35?

EL-BAZ Yes. And there are no clouds.

STAFFORD That was in the North Atlantic.

EL-BAZ Yes.

STAFFORD There's the one with the cloud pattern, but also we saw some that weren't that big, kind of in groups of threes. They were more something like that. There were three and then three one time that we shot.

EL-BAZ So you did see icebergs on two or three revolutions?

STAFFORD Yes.

EL-BAZ Very good. Is this the last slide? In conclusion, I want to thank you very much for a terrific job. I want to thank you first for spending the time for the training required for this experiment and also for your help in getting most

of that stuff in the Flight Plan and certainly for your tremendous effort in trying to get most of the stuff. I'm sure we will put it to good use. On behalf of everybody here, I'd like to thank you. Do you have something to say?

STAFFORD I've got a question. I don't know whether anybody's seen another two or three pictures I hope we got, of some structure which I think is in China or Mongolia. I don't know whether I mentioned that to you or not. It looked like a great big riverbed coming out of the north and fanning out over a very large area. It just looked like a sandy, dry riverbed coming down and spreading out this way. It was quite a bit north of our orbit and, considering the distance, it had to be a very mammoth structure of some kind. I shot three or four pictures of it, I think. Did you see anything that looked like that?

SPEAKER It maybe on that one roll we have left.

BREED Was this in the northern part of China?

STAFFORD That would be my guess as to where it was. Yes.

BREED I think I know what you mean. I hope you did get a picture of it.

STAFFORD It was a very unusual looking thing. Considering the size of it, if I was looking at it from 10 000 feet I'd have said, "That's a mammoth old dry riverbed." But from that altitude, it would really have to be mammoth. It just kind of fanned out. It just looked like a sandy river bottom.

BREED That's exactly it. I have an ERTS image over that area. I can't quite pick out what those things are. So if you got a picture, that would be really a picture we could use.

EL-BAZ Very good. Nat, do you have anything further?

HARDEE Okay. I had about three comments. One, again I'd like to congratulate both the crew and Farouk's team, the visual observations team, for a very successful experiment and for all their hard work. And also I'd like to thank the LSI for all their fine hospitality shown here today. And one note of information. The science briefing tomorrow is scheduled in the Gilruth Center.

END OF TRANSCRIPT